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PULSE DESCRIPTOR WORD COLLECTOR**STATEMENT OF GOVERNMENT INTEREST**

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefore.

15

BACKGROUND OF THE INVENTION**1. Field of the invention.**

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The invention relates to electronic surveillance (ES) and electronic counter measure (ECM) systems and, in particular, to a portable device capable of passively collecting and storing all digitized radio frequency (RF) pulse data received by an electronic surveillance system. The invention further relates to the method by which the device collects and stores said data.

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2. Description of the Background.

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Electronic Surveillance ("ES") systems are used on all modern United States (U.S.) Navy ships. These systems receive RF signatures in the form of pulse data and digitize them. The data is then processed in order to identify signals and determine the nature of the signals, threatening or non-threatening, for the purpose of theater awareness and self-defense. The data processing is typically accomplished by sending the data through a presorter, filtering it, and comparing the filtered data to stored sets of parameters. Monitoring the performance of processors within ES systems currently in use on U.S. Navy ships is required for continued improvement in recognition capabilities.

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5 Previously, such monitoring was accomplished by analyzing the ES system's response to controlled stimuli. The stimuli is typically supplied by radiating RF modulated pulses at the ES system antennas, injecting RF modulated pulses into the ES system cables, or using system specific built-in-test (BIT) capabilities. Each of these methods supplies RF modulated pulses that the ES system processes into digital PDWs. .

10 The ES system responds to the supplied RF pulses by either displaying the correct threat identification or producing active transmissions based upon a correct threat identification. Recordings are made of the response. By analyzing the recordings a judgment can be made on how well the system works.

Unfortunately, due to the ever-increasing complexity and density of emissions in

15 the RF spectrum this method of assessing ES system performance is out-dated and insufficient. Specifically, it does not allow for a more detailed analysis, based upon a realistic and comprehensive RF environment, to determine the cause of an incorrect response. Adequate assessment of the performance capabilities of a particular ES system requires an in-depth analysis of all received (vice supplied) RF pulse activity for a given

20 time period. Only with such an assessment can there be a realistic improvement in the development of radar and threat recognition algorithms.

Many ES systems and electronic counter measure (ECM) systems have the ability to sample and temporarily store the RF parameter data of a singular received RF pulse. This pulse is finely sampled across its duration. This sampling information allows the re-

25 creation of the pulse for output. However, modern ES and ECM systems do not possess long-term multi-pulse storage capability. In ECM systems the goal of the memory is to affect a short delay in the retransmission of data. This delay equates to range when

5 . viewed from a hostile perspective. Digital radio frequency memory (DRFM) or other
memory is used to capture, store and then retransmit RF energy a short time later. This
is often referred to as an RF delay line. Once the data has been re-transmitted, it is no
longer held in memory. For example, U.S. Patent Numbers 4,891,646, 4,713,662 and
4,743,905 to Wiegand , U.S. Patent Number 4,885,587 to Wiegand et al., and U.S. Patent
10 Number 4,928,104 to Schaffer all discuss various forms of DRFM for use within ECM
systems. Specifically, these DRFMs are designed for use within active radar jamming
systems. In each form the purpose of the DRFM is to allow the radar jamming system to
capture received radar signals, manipulate or alter them in time or phase, as necessary,
and return them on demand to confuse enemy radar systems. U.S. Patent Number
15 5,032,839 to Even-Or employs optical RF memory for the same purpose.

Several other prior art references also disclose the use of short-term memory to
improve the speed and accuracy of ECM or ES systems.

U.S. Patent Number 4,145,691 to Freeling et al. patents a memory system which
finds particular use in ECM systems. It uses memory to establish a feedback loop to re-
20 circulate RF burst signals which are emitted by enemy radar systems.

U.S. Patent Number 4,217,580 to Lowenschuss discloses a complete ECM
system. In this system RF signals are converted to digital words. The digital words are
then pre-sorted. Once a predetermined number of digital words associated with one radio
frequency signal is collected, that data is passed to a computer. This computer will then
25 compare the signature to that of a library, recognize the threat and determine the counter
technique called jamming. U.S. Patent Number 4,879,561 to Inkol discloses a filter
system for analyzing interleaved pulse descriptor words (PDW) received from a

5 multiplicity of radar signals. This system incorporates a buffer memory. The buffer memory is organized to allow data corresponding to a particular radar emitter to be efficiently accessed for further analysis within the radar system.

U.S. Patent Number 4,025,920 to Reitboeck et al. discloses an apparatus and method for identifying incoming radar signals by comparing them with stored sets of
10 parameters. Similarly, a radio frequency detection and collection system (RFD/CS) produced by Wide Band Systems, Inc. uses an antenna array and instantaneous frequency measurement (IFM) receivers to collect RF signals and convert them into PDWs. The PDWs are then transmitted to a computer workstation for analysis. The purpose of the computer workstation in this RFD/CS system is used to compare the incoming PDWs
15 with stored parameters in order to identify the intercepted emissions. None of the above-mentioned references discloses a system that records the total RF environment for long-term use.

Thus, there is a need for a portable PDW collector designed to passively collect and record all received RF emissions for later comparative analysis in a laboratory
20 environment. This portable PDW collector enables the capture for analysis of all RF activity within any given theater of operation or important point around the world. Such a PDW collector would provide a convenient and cost-effective device that can easily be carried onboard a U.S. Navy vessel and integrated into its ES system. The alternatives to this solution, including installation on each vessel of another independent ES system
25 capable of collecting the required data or an invasive redesign of all ES systems, are cost prohibitive.

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SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus for passively collecting and recording all digitized RF pulse data received by a ship's ES system. The digitized data typically includes parameters such as time of arrival, angle of arrival, amplitude, pulse width and frequency.

It is another object of this invention to provide a method for collecting and recording digitized RF pulse data. As described above, the collected data can be analyzed in order to test the detection and identification capabilities of current ES systems and to improve upon those detection and identification capabilities.

The foregoing and other objects are generally obtained by providing a pulse descriptor word collector (PDW collector) comprised of a PDW extractor and a PDW computer.

The object of the PDW extractor is to coincidentally collect all RF pulse data as the ES system receives it without impacting upon normal ES operations or intruding into ES system Ship Replaceable Units (SRUs). The ES system receiver receives RF pulse data, formats it into digital pulse descriptor words (PDWs), and forwards the data to the ES system presorter. The PDW collector is integrated into a ship's ES system between the ES system receiver and presorter. All PDWs that are transmitted from the receiver are diverted to the PDW extractor, flowing through the PDW extractor and on to the presorter. The PDW extractor passively monitors the transmissions carrying PDW data. Once data collection is initiated, the PDW extractor captures the incoming data, storing it in memory and simultaneously allowing the data to flow unaltered and uninterrupted to the ES system presorter. The PDW extractor then internally processes the captured data.

5 Upon capturing PDW data, the PDW extractor initially stores the data in a buffer or holding register. It then writes the data onto one of two RAM circuits. Incoming PDWs are written on to one of the RAM circuits, while PDWs that were previously stored on the other RAM circuit are simultaneously read to and stored on the PDW computer. The object of this continuous read/write loop is to ensure that no data is lost.

10 The object of the PDW computer is (1) to control the functions of the PDW extractor, (2) to provide long term storage for all received PDW data, and (3) to store, analyze and manipulate said data using data management software. The PDW computer controls the PDW extractor through specially written graphical user interface (GUI) software and multi-state sequencing software. The GUI software gives the user point and
15 click control of the PDW extractor, allowing the user to initiate and/or terminate data collection. The multi-state sequencing software controls the data processing within the PDW extractor. Specifically, the sequencing software controls the RAM Control within the PDW extractor by: (1) monitoring a strobe that indicates data is being received by the ES system and is ready for collection; (2) selecting which RAM circuit to write the data
20 on to; (3) writing the data onto the RAM circuit; (3) switching the RAM functions from write to read and vice versa; and, (4) reading the data to the PC computer.

 The foregoing PDW collector has enough speed and memory to record all RF signals present in the dense pulse environments of any given theater for an extended length of time. Specifically, the PDW collector is capable of collecting a minimum of
25 one million RF pulses per second. The preferred embodiment of this invention provides for storing the collected data on the PDW computer on high-speed Redundant Array of Independent Disks (RAID) hard drives.

5 The above-described apparatus, capable of operating on any ship class using an ES system, is portable (easily from ship to ship or from ship to laboratory) and acts as a referee receiver (providing redundant proof of the signals received).

BRIEF DESCRIPTION OF THE DRAWINGS

10 The following figures are illustrative of the preferred embodiment of the present invention:

 Figure 1 is a block diagram illustrating the integration of the PDW collector, including the PDW extractor and the PDW computer, into an ES system.

 Figures 2 and 2.1 are a detailed block diagram of the PDW collector, illustrating
15 the hardware configuration and interconnections.

 Figures 3A-3G.2 are detailed schematic diagrams of the RAM circuitry.

 Figure 4 is a diagram illustrating the RAM circuit card assembly layout.

 Figures 5-5.2 are drawings illustrating the RAM circuit card interconnections.

 Figures 6A-6C.2 are detailed schematic diagrams of the RAM control circuitry.

20 Figure 7 is a diagram illustrating the RAM control circuit card assembly layout.

 Figures 8-8.1 are diagrams illustrating the PDW extractor's electrical flow.

 Figures 9-9.1 are schematic diagrams of the power supply (converter).

 Figure 10 is a diagram illustrating the power supply circuit card assembly layout.

 Figure 11-11.1 is a drawing illustrating the PDW extractor's internal harnessing.

25 Figure 12 is a drawing illustrating the PDW extractor's exterior mechanical assembly.

5 Figure 13 is a diagram illustrating the interface between the PDW extractor and the PDW computer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

10 The present invention, a pulse descriptor word (PDW) collector, comprises an apparatus for controlled collecting and recording of all RF pulse data received by a ship's electronic surveillance (ES). The PDW collector coincidentally collects the RF pulse data as the ES system receives it (after formatting into digitized PDW data). The PDW collector includes: (1) a portable PDW extractor unit 10, and (2) a high-speed PDW
15 computer 20.

FIG. 1 illustrates that the PDW extractor 10, an electronics unit, is integrated with a ship's ES system after the point at which RF signals have been converted into PDW data by the ES system receiver and parallel to the point where the PDW data is processed by the ship's ES system presorter 1A4. The PDW extractor 10 has an input connection
20 J1 for powering the unit. In addition it has input connections J7, J2, and J3 connected to ship's cables W35, W36, and IW23, respectively, which are in turn connected to the ship's ES system receiver. Input/output connection J6 is for receiving instructions from and sending data to the PDW computer 20.

Data captured and stored by the PDW extractor 10 is also simultaneously
25 forwarded, unaltered and uninterrupted, to the ES system presorter 1A4 via output connections J8, J9, and J10 which are connected, respectively, by cables W35, W36, and 1W23 to the ship's ES system presorter 1A4 at its input connections, J7, J2, and J3.

5 Thus, the PDW extractor 10 and the ES system presorter 1A4 are able to processes the same data at the same time.

Figures 2-2.1 form a detailed block diagram illustrating the hardware configuration and interconnections of the preferred embodiment of the present invention. Referring to FIG. 2.1, using a graphical user interface (GUI) 33, supported by specially
 10 written software, a user initiates data collection via the PDW computer 20.

Communication between the PDW computer 20 and the PDW extractor 10 occurs via input /output connections J6 on the PDW extractor 10 and J11 on the PDW computer 20. Multi-state sequencing programs 34 within the PDW computer 20 are designed to control the PDW extractor 10. Specifically, these sequencing programs 34 control the RAM
 15 control 15 within the PDW extractor 10 (see FIG. 1). The RAM control 15 then regulates the storage of data onto RAM circuits A and B, 21 and 22 respectively. Figures 3A-3G.2, 4 and 5-5.2, illustrate the RAM (21 and 22) schematics, circuit card assembly layout, and circuit card interconnections, respectively. Figures 6A-6C.2 and 7, illustrate the RAM control 15 schematics and circuit card assembly layout, respectively

20 Referring to FIG. 2, the host ship's ES system receiver includes a starboard antenna angle encoder 23, a port antenna angle encoder 24 and a coarse frequency receiver (CFR) 25. These angle encoders produce digital word data based on both the amplitude (AMP) and the angle of arrival (AOA) of received RF signals. The starboard antenna angle encoder 23 transmits AMP and AOA PDWs via the ship's cable W35 to
 25 input J7 on the PDW extractor 10. The port antenna angle encoder 24 transmits AMP and AOA PDWs via ship's cable W36 to input J2. The CFR 25 produces PDWs based

5 on the frequency (FREQ) of received RFs and transmits these PDWs via ship's cable
1W23 to input J3.

Once the transmitted PDWs enter the PDW extractor 10, the AMP and AOA
PDWs are transmitted within the PDW extractor 10 through internal connectors J9/J10
and J10/J11/J12 to angle/amplitude boards B2 and B3, where the data is captured and
10 held. Frequency PDWs are transmitted through internal connector J6 to the frequency
formatter 14 and formatted.

Timing of all functions within the PDW extractor 10 is managed based upon a
clock generator 16. The exterior front panel of the clock generator 16 has a run/load
toggle switch and a push button reset which allow the user to place the extractor into
15 operations mode or to initialize the internal sequencer. Timing alignment controls 11 on
the front panel 12 of the PDW extractor 10 are adjustable by the user so that the timing of
the data flow control (DFC) time coincidence 13 synchronizes the timing of the PDW
extractor 10 with that of the host ship's ES system. In order to accomplish the required
timing alignment, the timing alignment controls 11 cause potentiometers 31, to send
20 voltage signals into the circuit boards holding the angle, amplitude and frequency data.

Once the timing adjustment is complete, AOA, AMP and FREQ PDWs are
forwarded to the PDW buffer 17. The PDW buffer 17 is a holding register where PDW
data is held until it is stable and the RAM control 15 can write the data on to the RAM
memory (21 and 22). The time of arrival (TOA) 19 of each PDW into the PDW buffer
25 17 is monitored by the clock generator 16. PDWs are clocked in to and out of the PDW
buffer 17 using a first in-first out (FiFo) control logic 18. When the PDW buffer 17 holds

5 PDW data, it sends a strobe 35 out to the RAM control 15 (see FIG. 2.1), informing the RAM control 15 that there is data waiting to be collected.

Again referring to FIG. 2.1, RAM control 15 and the two high-speed integrated RAM circuits, RAM A (21) and RAM B (22), are powered by a 2.5 volt power source (PS) 32. This power source 32 contains a power converter for converting a 5 volt direct
10 current into the required 2.5 volts. A diagram of the PDW extractor's electrical flow is presented in Figure 8. Figures 9-9.1 and 10 illustrate the power converter schematics and the power converter assembly layout.

The writing of data onto RAMs A (21) and B (22) and the reading of data from RAMS A (21) and B (22) are controlled by the read/write select 42 and the read/write
15 control 41 mechanisms of the RAM control 15 that is in turn controlled by the multi-state sequencing software 34 of the PDW computer 20. The purpose of these two RAM circuits (21 and 22) is to allow the PDW extractor 10 to write new PDW data onto one RAM (ie. 21), while at the same time reading PDW data previously stored on the other RAM (ie. 22) to the PDW computer 20. This write/read loop using two RAMs allows for
20 continuous long-term data collection and is designed to ensure that no data is lost.

Using the GUI 33 and data management software 36 within the PDW computer 20, the user assigns a base file name to the data to be collected and initiates the data collection process. The RAM control 15 has a strobe monitor 43 for monitoring the PDW strobe 35 from the PDW buffer 17. When the PDW strobe 35 indicates to RAM
25 control 15 that data is ready to be collected, read/write select 42 determines which RAM to write the data on to and read/write control 41 initiates the writing of PDWs onto the selected first RAM (ie. 21). As each PDW is written on to the first RAM, a write counter

5 (37 or 39 depending on which RAM is in the write mode) is incremented to indicate how many PDWs are being stored. Writing continues onto the first RAM until an interrupt, programmed by the sequencing software 34 of the PDW computer 20, simultaneously forces the read/write select 42 to switch the first RAM circuit (21) into the read mode and the second RAM circuit (22) into the write mode. In the current embodiment of this
10 invention, this interrupt is set at 1 second. Control to each RAM circuit is complementary. The sequencing programs 34 then read the write counter from the first RAM to determine the total number of stored pulses, and then reads that amount of stored PDW data to the PDW computer 20. A read counter (38 or 40 depending on which RAM is in the read mode) within the RAM insures that the PDW computer 20 is reading the
15 correct number of PDWs. This read/write loop repeats at each interrupt. Lastly, the PDWs that are read to the PDW computer 20 are stored onto a RAID hard drive 37 within the PDW computer 20 for retention and later analysis.

Data management software 36 is written so that it is able to read stored PDW data from the hard drive, compact CD disk, DVD or other storage medium and format the data
20 into usable (binary to decimal, etc) terms. During analysis the data parameters may be plotted into a variety of graphics such as, pulse frequency versus time of arrival, pulse frequency versus angle of arrival, amplitude versus angle of arrival, etc. The data management software 36 filters ranges of several parameters and stores these as spread sheet files. The data management software 36 is also able to relate the parameters in high
25 resolution and format the files to play back in laboratory environment. Ultimately, once all the digitized RF pulse data from a selected theater of operation during a particular

- 5 time period is captured, the ES system engineers can replay an entire event to monitor, assess, develop and update threat identification software.

Three multi-state sequencing programs 34, set out below, were developed for the preferred embodiment of this invention. Sequencing program 1 primarily controls the sequence of the processes within the PDW extractor 10 based upon input stimulus.

- 10 Sequencing programs 2 and 3, along with sequencing program 1, control the outputs that in turn control data paths, write strobes, etc, all based on the "state" of the sequencer.

SEQUENCER PROGRAM 1

```

15  C      SET UP THE STATE FIELD
      PSTAT=A0+2*A1+4*A2+8*A3+16*A4+32*A5

  C      SET UP THE INPUT CONTROL BITS

20  DACK=A6
      READ=A7
      NEWPDW=A8
      GROUND=A9

25  NSTAT=PSTAT

  C      SET UP THE OUTPUT BITS' DEFAULT CONDITIONS

30  CLKEN=1
      OERAM=1

  C      SET UP THE STATES
  C      SEQUENCER STARTS AT 0 AND DEPENDENT ON READ MODE GOES TO RD/WR
  C      LOO
35  C      READ LOOP STARTS AT 1, WR LOOP STARTS AT 32

      IF(PSTAT.EQ.0.AND.READ.EQ.1)NSTAT=1
      IF(PSTAT.EQ.0.AND.READ.EQ.0)NSTAT=32

40  C      WATCH FOR CHANGE OF READ STATUS AT TOP OF WRITE AND READ LOOP

  C      FOLLOWING IS THE READ SEQUENCE *****

45  C      STORE LAST ADDRESS,CLR COUNTER,HANDSHAKE WITH DIO FOR # WORDS

      IF(PSTAT.EQ.1.AND.READ.EQ.1)NSTAT=2
      IF(PSTAT.EQ.1.AND.READ.EQ.0)NSTAT=32

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5      IF(PSTAT.EQ.2)NSTAT=3
      IF(PSTAT.EQ.3.AND.DACK.EQ.1)NSTAT=4
      IF(PSTAT.EQ.4)NSTAT=5
      IF(PSTAT.EQ.5.AND.DACK.EQ.1)NSTAT=6
      IF(PSTAT.EQ.6)NSTAT=7
10
      C      SET READ ADDRESS, HANDSHAKE WITH DIO FOR PDW, INC READ ADDRESS

      IF(PSTAT.EQ.7)NSTAT=8
      IF(PSTAT.EQ.8)NSTAT=9
15      IF(PSTAT.EQ.9)NSTAT=10
      IF(PSTAT.EQ.10.AND.DACK.EQ.1)NSTAT=11
      IF(PSTAT.EQ.11)NSTAT=12
      IF(PSTAT.EQ.12.AND.DACK.EQ.1)NSTAT=13
      IF(PSTAT.EQ.13)NSTAT=14
20      IF(PSTAT.EQ.14.AND.DACK.EQ.1)NSTAT=15
      IF(PSTAT.EQ.15)NSTAT=16
      IF(PSTAT.EQ.16)NSTAT=8

      C      START WRITE SEQUENCE
25
      IF(PSTAT.EQ.32.AND.READ.EQ.1)NSTAT=1
      IF(PSTAT.EQ.32.AND.NEWPDW.EQ.1)NSTAT=33
      IF(PSTAT.EQ.33)NSTAT=34
      IF(PSTAT.EQ.34)NSTAT=35
30      IF(PSTAT.EQ.35)NSTAT=36
      IF(PSTAT.EQ.36)NSTAT=37
      IF(PSTAT.EQ.37.AND.NEWPDW.EQ.1)NSTAT=33

      C      CHECK FOR CHANGED READ MODE IF SO GOTO 0
35
      IF(PSTAT.EQ.3.AND.READ.EQ.0)NSTAT=32
      IF(PSTAT.EQ.5.AND.READ.EQ.0)NSTAT=32
      IF(PSTAT.EQ.8.AND.READ.EQ.0)NSTAT=32
      IF(PSTAT.EQ.10.AND.READ.EQ.0)NSTAT=32
40      IF(PSTAT.EQ.12.AND.READ.EQ.0)NSTAT=32
      IF(PSTAT.EQ.14.AND.READ.EQ.0)NSTAT=32

      C      CHECK FOR CHANGED READ MODE IF SO GOTO 0

45      IF(PSTAT.EQ.37.AND.READ.EQ.1)NSTAT=1

      C      SET UP CONTROL BITS VS. STATE

      C      READ
50
      IF(PSTAT.EQ.8)CLKEN=0    clockenable clken is used for rams
      IF(PSTAT.EQ.9)CLKEN=0
      IF(PSTAT.EQ.10)CLKEN=0

55      IF(PSTAT.EQ.10)OERAM=0  output enable ram oeram allows the
      ramoutput

      C      WRITE

60      IF(PSTAT.EQ.33)CLKEN=0
      IF(PSTAT.EQ.34)CLKEN=0

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5      IF (PSTAT.EQ.35) CLKEN=0
      C      SET UP CONTROL BIT POSITIONS
      DATA=NSTAT+64*CLKEN+128*OERAM
10

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SEQUENCER PROGRAM 2

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      PSTAT=A0+2*A1+4*A2+8*A3+16*A4+32*A5

      ADV=0 advance counter
15     WE=1 write enable into ram
      STRADD=0 store address of last pdw
      CLRPDW=1 clear pdw ready flag
      INCCNT=0 increment counter
      CLRCNT=1 clear counter to zero
20     ADDOE1=1 address counter output enable to pc
      ADDOE2=1 address counter output enable to pc

      IF (PSTAT.EQ.33) WE=0
25     IF (PSTAT.EQ.34) WE=0
      IF (PSTAT.EQ.35) WE=0

      IF (PSTAT.EQ.1) STRADD=1

30     IF (PSTAT.EQ.0) CLRPDW=0
      IF (PSTAT.EQ.36) CLRPDW=0

      IF (PSTAT.EQ.16) INCCNT=1
35     IF (PSTAT.EQ.36) INCCNT=1

      IF (PSTAT.EQ.0) CLRCNT=0
      IF (PSTAT.EQ.2) CLRCNT=0
      IF (PSTAT.EQ.32) CLRCNT=0

40     IF (PSTAT.EQ.4) ADDOE1=0
      IF (PSTAT.EQ.6) ADDOE2=0

      DATA=ADV+2*WE+4*STRADD+8*CLRPDW+16*INCCNT+32*CLRCNT+64*ADDOE1
45     &+128*ADDOE2

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SEQUENCER PROGRAM 3

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      PSTAT=A0+2*A1+4*A2+8*A3+16*A4+32*A5

      C      SET UP INPUT CONTROL BIT POSITIONS
50     C      SET UP THE OUTPUT BITS' DEFAULT

      OE1=1 enable output data to pc
      OE2=1 enable output data to pc
55     OE3=1 enable output data to pc

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5      PCLK=0      clock data to pc
      DIRQST=0     request pc get data
      BUFFEN=1     output data buffer enable
      READEN=1     enable reading
      OUTCLK=0     clock to pc
10
C      SET UP THE CONTROL BITS VS STATE

      IF(PSTAT.EQ.11)OE1=0
      IF(PSTAT.EQ.13)OE2=0
15     IF(PSTAT.EQ.15)OE3=0

      IF(PSTAT.EQ.3)PCLK=1
      IF(PSTAT.EQ.4)PCLK=1
      IF(PSTAT.EQ.6)PCLK=1
20     IF(PSTAT.EQ.10)PCLK=1
      IF(PSTAT.EQ.11)PCLK=1
      IF(PSTAT.EQ.13)PCLK=1
      IF(PSTAT.EQ.15)PCLK=1

      IF(PSTAT.EQ.3)DIRQST=1
      IF(PSTAT.EQ.4)DIRQST=1
      IF(PSTAT.EQ.5)DIRQST=1
      IF(PSTAT.EQ.6)DIRQST=1
      IF(PSTAT.EQ.7)DIRQST=1
30     IF(PSTAT.EQ.8)DIRQST=1
      IF(PSTAT.EQ.9)DIRQST=1
      IF(PSTAT.EQ.10)DIRQST=1
      IF(PSTAT.EQ.11)DIRQST=1
      IF(PSTAT.EQ.12)DIRQST=1
35     IF(PSTAT.EQ.13)DIRQST=1
      IF(PSTAT.EQ.14)DIRQST=1
      IF(PSTAT.EQ.15)DIRQST=1
      IF(PSTAT.EQ.16)DIRQST=1

      IF(PSTAT.EQ.4)BUFFEN=0
      IF(PSTAT.EQ.6)BUFFEN=0
      IF(PSTAT.EQ.11)BUFFEN=0
      IF(PSTAT.EQ.13)BUFFEN=0
40     IF(PSTAT.EQ.15)BUFFEN=0

      IF(PSTAT.EQ.1)READEN=0
      IF(PSTAT.EQ.2)READEN=0
      IF(PSTAT.EQ.3)READEN=0
      IF(PSTAT.EQ.4)READEN=0
45     IF(PSTAT.EQ.5)READEN=0
      IF(PSTAT.EQ.6)READEN=0
      IF(PSTAT.EQ.7)READEN=0
      IF(PSTAT.EQ.8)READEN=0
      IF(PSTAT.EQ.9)READEN=0
50     IF(PSTAT.EQ.10)READEN=0
      IF(PSTAT.EQ.11)READEN=0
      IF(PSTAT.EQ.12)READEN=0
      IF(PSTAT.EQ.13)READEN=0
      IF(PSTAT.EQ.14)READEN=0
55     IF(PSTAT.EQ.15)READEN=0
      IF(PSTAT.EQ.16)READEN=0
60

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```
IF (PSTAT.EQ.10)OUTCLK=1
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```
DATA=1*OE1+2*OE2+4*OE3+8*PCLK+16*DIRQST+32*BUFFEN+64*READEN  
&+128*OUTCLK
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Figures 11-11.1 form a drawing illustrating the PDW extractor's internal harnessing.

Figure 12 is a drawing illustrating the PDW extractor's exterior mechanical assembly.

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Figure 13 is a diagram illustrating the connector interface between the PDW extractor and the PDW computer.

Having now fully set forth the preferred embodiment and certain modifications of the concept underlying the present invention, various other embodiments as well as certain variations and modifications of the embodiments herein shown and described will obviously occur to those skilled in the art upon becoming familiar with said underlying concept. It is to be understood, therefore, that the invention may be practiced otherwise than as specifically set forth in the appended claims.